

Figure 1-Schematic for the fabrication of bimorph cantilever actuators. SWNT-Nafion Composite thin film electrodes were applied to each side of a polyimide substrate; electrical contacts were applied with a sealed clamp.

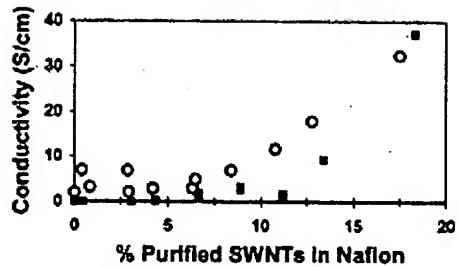


Figure 2. Conductivity for various percent by weight h-SWNT-Nafion composites are shown. The filled boxes represent the as-cast SWNT-composite membranes and the open circles the platinumized SWNT-Nafion composite membranes. Measurements were conducted using a standard four-point resistivity probe.

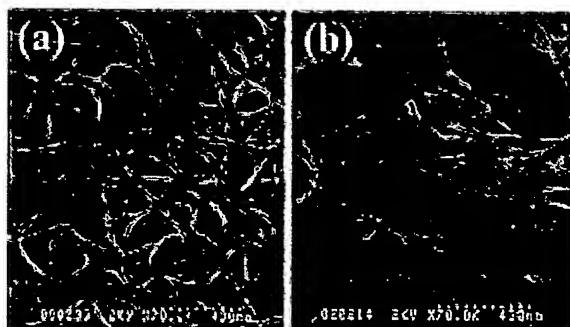


Figure 3. FESEM images depicting a 5-fold reduction in h-SWNT bundle diameter from (a) high purity, compared to (b) 10% w/w dispersion in Nafion.

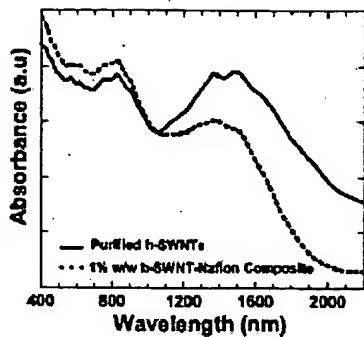


Figure 4. Overlay of the optical spectroscopy spectra for purified h-SWNTs and 1% w/w h-SWNT-Nafion composite with a Perkin-Elmer lambda 900 UV-vis-NIR spectrometer. Spectra were normalized at 1025 nm. A quench of the first van Hove singularity absorption intensity for the semiconducting SWNTs within the composite is evident at ~ 1450 nm.

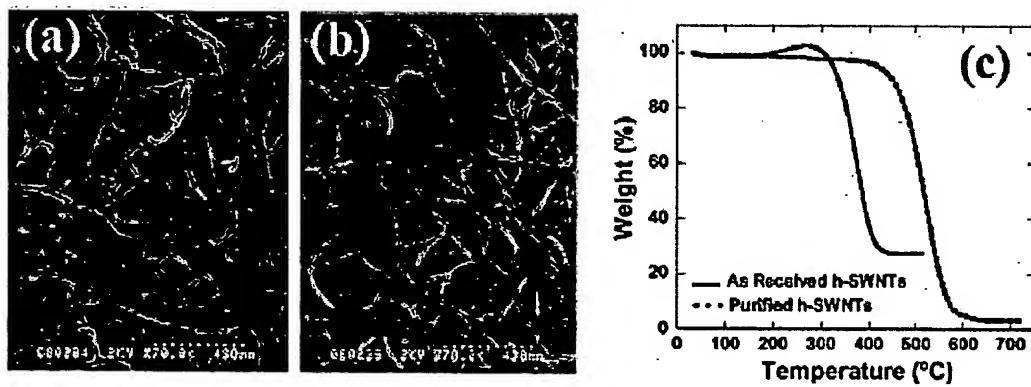


Figure 5. Analysis of h-SWNTs:
 (a) Hitachi model S-900 FESEM image of as-received material from Carbon Nanotechnologies Inc., the carbonaceous coating is clearly evident; (b) FESEM image of high-purity, $>95\%$ w/w, h-SWNTs after purification; (c) TA Instruments model 2950 thermogram overlay displaying the decomposition of as-received and purified h-SWNT samples, $5\text{ }^{\circ}\text{C}/\text{min}$ under 60 sccm flowing air atmosphere.

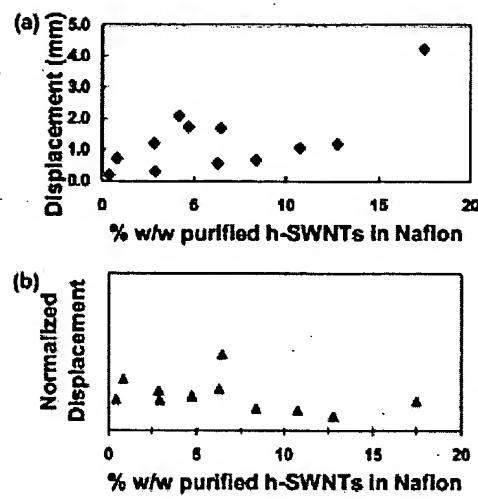


Figure 6. Actuation properties of the platinized h-SWNT-Nafion composite series. The magnitude of actuation of the bimorph cantilever tip was determined with optical deflection analysis: (a) cantilever tip displacement observed from a square-wave excitation voltage of 2 V at a frequency of 1 Hz, (b) the displacement data in (a) normalized to the respective composite conductivity.

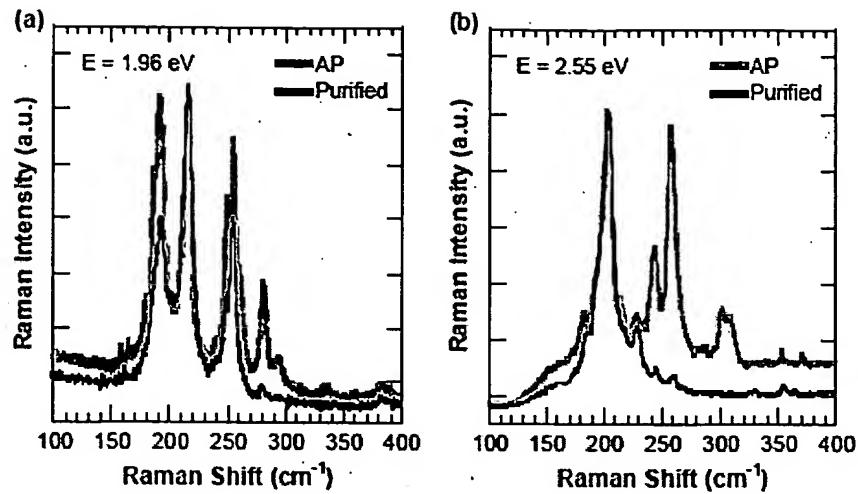


Fig. 7. Shown is the radial breathing mode (RBM) from the Raman spectra of AP (gray) and purified, > 95% w/w h-SWNTs (black), for incident laser energies of (a) 1.96 eV and (b) 2.55 eV.

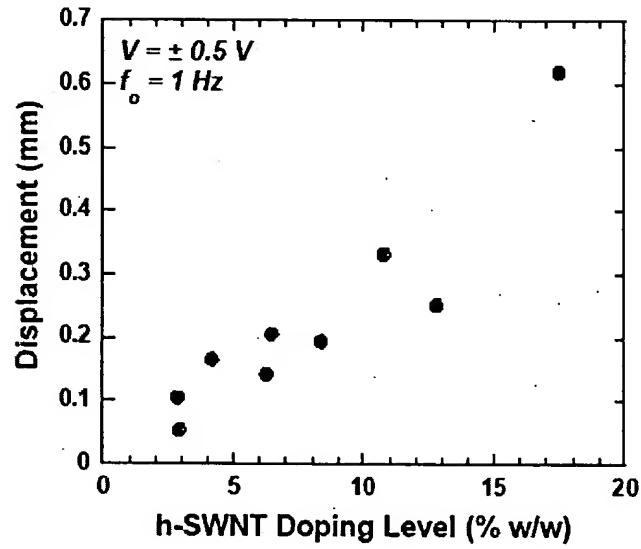


Fig. 8. Bimorph cantilever tip displacement data for varying percent by weight h-SWNT-Nafion composite actuators at an applied voltage of ± 0.5 V and an operating frequency of 1 Hz.

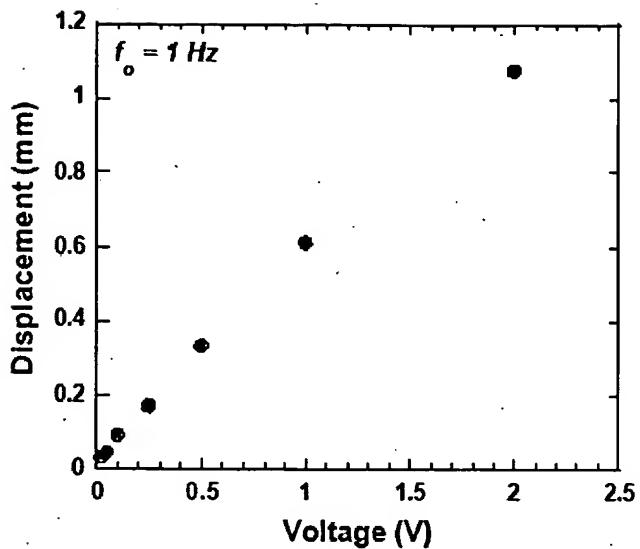


Fig. 9. Bimorph cantilever tip displacement data for a 10.8 % w/w h-SWNT-Nafion composite actuator as a function of voltage at an operating frequency of 1 Hz. The plot shows the linear dependence of applied voltage on tip displacement.

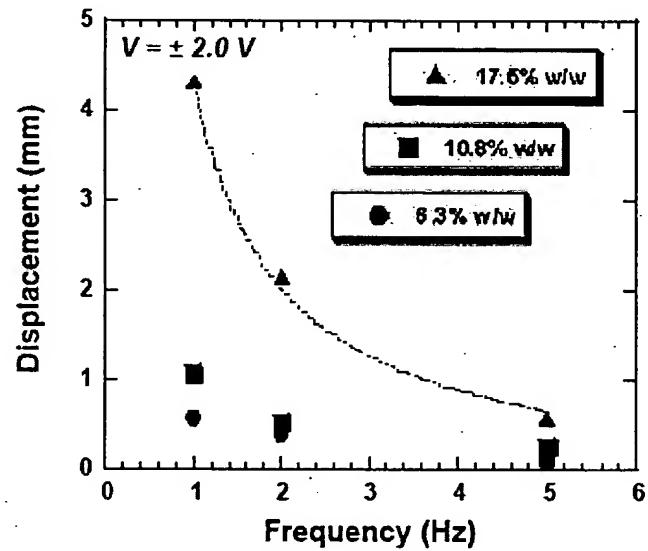


Fig. 10. Bimorph cantilever tip displacement (d) data for 6.3, 10.8, and 17.5 % w/w h-SWNT-Nafion composite actuators at an applied voltage of $\pm 2.0 \text{ V}$ as a function of the operating frequency (f). The dashed curve represents the relationship, $d=1/f$.